APPENDIX 2

State of California

Business, Transportation and Housing Agency

Memorandum

To: ALL JOBS

Date: September 25, 1989

File:

From: **DEPARTMENT OF TRANSPORTATION**
DIVISION OF STRUCTURES
OFFICE OF STRUCTURE CONSTRUCTION

Subject: LOST DECK FORMWORK

Low velocity powder driven nails used to attach wood ledgers to concrete have been tested and approved for use in new contracts containing appropriate Special provision amendments to Section 51-1.05 "Forms" of the Standard Specifications. On going contracts, or contracts'which do not contain the appropriate Special Provision language, a Contractor requested Change Order may be written to permit the use of powder driven nails in the lost deck forming system, in accordance with Falsework Manual Memo No. 7 (6/14/89). The Office of Structure Construction has determined that an agreed price rebate of $.11 per square foot of lost deck area should be used in the change order.

A. P. BEZZONE, Chief
Office of Structure Construction

Inspection Check List for Bridge Deck Construction

Developed, from-Outline of Field Construction Procedures by Jon Mehtlan.

Deck construction actually starts with the soffit forms being properly graded and a check of the girder reinforcing steel stirrups. The length of the stirrups should be checked so that they will be at the correct height in the deck.

1. Lost Deck

   1) Make sure that soffit vents are clear, drains and there support systems are checked.

   2) Measure grade points contractor will use. Plot and pick grades on 4-scale.

   3) Shoot grade points and give Contractor cut/fill sheet to top of deck. If construction staking is an item, compare Contractor's submittal with ours and spot check grade points.

   4) Check stems for over height; no more than 0.1' into fillet (OSC Policy).

   5) Check bays for cleanness. No loose material allowed in bays (Standard Specifications 51-1.05)

   6) Check lost deck form work for compliance with approved submittal and workmanship.

   7) Use string line between grade points to check lost deck elevations, deck thickness.

   8) Seal any gaps and holes that will result in significant grout leaks.

   9) Finally, check adequacy of sandblasting done on tops of girders and clean up.

2. Overhang

   1) Determine what method the Contractor will use to grade overhang.

   2) Measure adjusting devices, plot and pick grades.

   3) Grade overhang. If construction staking is an item, spot check overhang grades as necessary to assure compliance.

4) Plywood overhang forms must conform to the same conditions as soffit plywood.

On sharp radius curves, gaps will occur between plywood and stem and at joints. Some pattern must be developed to mitigate this.

5) Eyeball edge of deck chamfer for smoothness.

6) Safety rail along edge of deck must go up as overhang is being formed and remain in place until the barrier rail has been completed.

3 Deck Reinforcing Steel

1) Check main cap reinforcement for size, number and end.

2) Main cap rebar should be tied into or blocked up to stirrup hooks.

3) **See Standard Plan BO-5** for spacing of transverse deck steel.

4) Check height of stem stirrup at bend. This will determine height of top mat. If stirrups ar to low, > 3/8", other methods like additional blocking will be required to achieve correct height of top mat.

5) Splice transverse deck steel if necessary as per Section **52-l.08 of the Standard Specifications.** Truss bars should preferably be spliced between girders.

6) Check bottom mat clearance (adequate blocking), height of top mat (additional blocking), and securely tied intersections. If mat feels loose, more ties and blocks are required.

Check barrier rail steel, extra bars needed at joints etc.

4. Deck Check Out Before Pour

Other items to be aware of in addition to steel:

1) Access openings in correct location; Are bolts, etc., in place and secure.

2) Blockouts for joint seal assemblies.

3) Is longitudinal construction joint located on lane line (Standard Plans BO-5).

4) Is transverse deck joint at 1/4 point (Standard Plans B0-5).

5) Are prestressing vents secure and retrievable. Strap tie to hand rail is a good way to find these later.

6) Check barrier rail steel and additional bars for electrical components (pull boxes).

7) Check end bulkheads for line and support.

8) Eyeball overhang chamfer and screed pipes for smooth line.

9) A check of the finishing machine roller clearance to the top mat of steel should be made by tying a piece of lath or other 2" thick guide across the bottom of the rollers and traversing the deck, back and forth from one end to the other.1 Record the deck thickness at various locations, and if it becomes apparent a pattern of too thick or too thin of a deck is developing, this can be corrected by adjusting the machine or the screeds.

10) Check height of deck drain inlets in relation to finishing machine roller.

5. Deck Pour

1) Verify mix design and check consistency of first few trucks.

2) Be sure lost deck forms and rebar are damp just ahead of pour front. On hot days, water keeps steel cool and will help prevent possible cracking.

3) Don't let pour front get more than 10 or 12 feet ahead of finishing machine. If it does,‘ stop placement until the machine can catch up.

4) Application of curing compound is to be by power

and should be as close as practical to the finishing operated equipment, **Standard Specifications 90-7.01B**, machine. During hot, windy conditions, application of water spray will certainly help prevent cracking on newly finished surface. Water based curing compound should not be placed on standing water as it will evaporate with the water.

5) If lost deck fails, all concrete must be removed from the bay/bays.

6) Applying rugs or mats shall begin within 4 hours after completion of deck finishing and no later than the next morning for portions finished after end of shift. **(Standard Specifications 90-7.03)**

7) Read **Standard Specifications 51-1.17,** "Finish Bridge Decks".

8) Recheck tattle tales for additional falsework settlement.

6. After Deck Pour

1) Periodically check rugs for dampness. Rugs generally need water at least twice a day.

2) Contractors generally remove cure rugs at end of cure period. This must be done to inspect deck for shrinkage cracks prior to prestressing or release of falsework as set forth in **Section 51-1.17 of the Standard Specifications.**

3) If deck surface does not meet the crack intensity specifications, Contractor is to be notified by letter noting the affected area.

7. Hinges

1) Establish a bench mark over a column once the deck is poured and use this to monitor hinges.

2) Monitor hinges thusly:

a) From tattle tales during stem pours, note any difference from that introduced to soffit grade.

b) Immediately after deck pour, establish elevations on deck (min. 3) just behind bulkhead, **say** 1'. Also establish a grid (over bent, 25' back, 50' back) so profile can be developed.

c) Shoot weekly until notified otherwise.

d) Before establishing long span final grades, profile short span deck (10' cc) and compare to theoretical. Spline out long span deck grades if appropriate.

e) Monitor long span same as short span.

f) If long span settles excessively, it may have to be jacked up (Contractor% expense).

g) If short span rotates up more than anticipated it can be ground out later (we usually pay).

3) Prior to installing joint seal assembly, the blocked void is filled usually with sand and topped with 3 to 4 inches of concrete to facilitate profilographing and grinding. Measures should be taken to prevent intrusion of sand into joint.

8. Approach Slabs

1) Grades for these are usually established by comparing with existing deck profile.

2) Treated permeable material is placed and compacted.

3) Fabric, rebar and waterstop are placed for sleeper slab and concrete is placed and finished.

4) Approach slab is placed next following same procedures.

5) Block outs for joint seal assemblies may be required here and are dealt with the same as hinge blockouts.

9. Profilographinq

1) Contractor cleans deck and requests we profilograph deck or decks. Seven (7) days prior notice required **(Standard Specifications 5l-1.17).**

2) Required trace lines are laid out along with stations or some such identification of distance and traces are run according to California Test 547.

3) "Must grinds" are marked on deck and Contractor is notified of their locations in writing.

4) Contractor should review profilograms, and determine how he proposes to bring the entire deck into specification (min. count etc.).

10. Deck Grinding

1) Contractor's foreman should be directing grinding operations.

2) Check behind grinder with straight edge to prevent unnecessary moves.

3) Reduction of high count areas is the Contractor's choice but would be nice to discuss method ahead of time.

4) When Contractor says he is finished, rerun profilograph.

HINGE CURL

This memo addresses the problem of upward deflection of the unloaded short cantilever of the hinged span of cast-in-place P/S concrete box girder bridges. This deflection is experienced prior to load transfer from the long span side and is commonly termed, "hinge curl".

The intent of the following procedure is to give the design engineer a means whereby this "hinge curl" deflection may be predicted and to provide appropriate data on the contract plans dealing with this problem.

The designer is reminded that there is avariable period of time (usually between 30 and 180 days, sometimes much longer) in which the short cantilever remains unloaded after it has been stressed. The period of time and, therefore, the extent of curl is not predictable until the contractor's schedule is known. Experience indicates that the hinge does not always deflect downward at load transfer to the extent that it had previously deflected upward under the influence of the prestressing force. In the past, the camber diagrams which have been shown on the plans have not solved the hinge deflection problem. The following procedure should produce good riding bridges.

Step 1 - Initial BDS Runs

Run BDS for complete structure (including all design loads) using maximum eccentricities for tendon paths. Review and modify prestress path for optimum stress and deflection control. Record P_j and deflections for all paths.

New Memo

Step 2 - Individual Frames

Run BDS for each frame. Place a temporary support at the end of the long hinge span. Use P_j from Step 1. Do not include live loads, weight of closure pour, barriers, future overlay, and/or transfer load from long hinge. Prestress deflections of the unloaded short hinge will be reported by these runs and may be checked with a simple calculation using the following equation:

Equation No. 1 – Uplift of Short Cantilever (see Sketch No. 1)

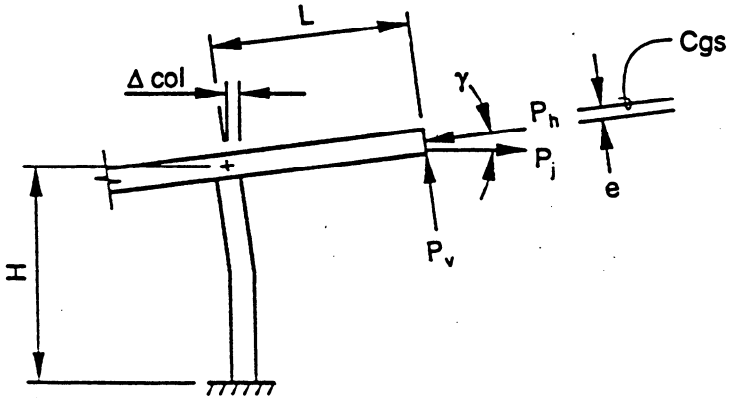
$$\Delta \text{ curl} = -\Delta \text{ col} \frac{L}{H} - \frac{P_v L^3}{3EI} \pm \frac{P_h e L^2}{2EI} + \frac{wL^4}{8EI}$$

(down is positive)

and where:

- w = unit dead load of cantilever
- L = length of cantilever measured to C_L of support
- P_h = horizontal component of P_j
- P_v = vertical component of P_j
- Δ col = deflections of column due to prestress shortening
- H = column height
- e = eccentricity of prestress at hinge
- E = 3,600 ksi = 518,400 ksf ($E = 57{,}000 \sqrt{f'_c}$)

In Equation No. 1, the first term represents the uplift effect due to column deflection. The second and third terms are effects of the prestressing and the last term is the dead load deflection of the unloaded cantilever.



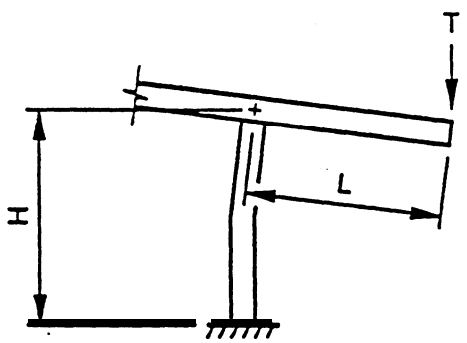
Sketch No. 1

A second run of the short hinge frame, loaded this time with the hinge transfer load at the end of the cantilever, (include hinge concrete) will produce a downward deflection at the hinge. This deflection can be verified quickly with the following equation:

Equation No. 2 -Downward Deflection of Short Cantilever (see Sketch No. 2)

$$\Delta \text{ reaction } = \frac{TL^3}{3EI}$$

where T = Transfer Load (include hinge concrete)



Sketch No. 2

Step 3 - Development of Plan Camber Diagram

This step involves incorporating the predicted deflections into the camber diagram to be shown on the contract plans. The long term effect of creep and **shrinkage** is assumed to result in ultimate deflection three (3) times as great as immediate deflection and this will occur over a four year period. Since the load transfer from the long hinge will usually occur sometime early in the period from 30 to 720 days after prestressing the short hinge span, a camber diagram with tabulated values is to be shown on the plans.

The suggested camber diagram to be drawn for the hinged span is shown in Figure 1. The normal diagram is show along with an enlarged camber curve for the hinge span. Three values of camber are calculated and shown at the hinge. Camber "A" is calculated for the position of the long hinge side and Camber "B" is calculated for the position of the short hinge side, value "C" is the measurement from "A" to 'B".

Previously calculated deflections are modified for long term effects as follows:

Camber "A"' - Camber required for transfer dead load less prestress uplift after load transfer (may be positive or negative value).

30 day value = 2.60 × Δ reaction - 1.60 × Δ curl
60 day value = 2.20 × Δ reaction - 1.20 × Δ curl
90 day value = 1.80 × Δ reaction - 0.80 × Δ curl
120 day value = 1.60 × Δ reaction - 0.60 × Δ curl
180 day value = 1.55 × Δ reaction - 0.55 × Δ curl
240 day value = 1.50 × Δ reaction - 0.50 × Δ curl
360 day value = 1.40 × Δ reaction - 0.40 × Δ curl
720 day value = 1.25 × Δ reaction - 0.25 × Δ curl

Camber "B" - Camber required for short hinge side (may be positive or negative value).

30 day value = 2.60 × Δ reaction - 3.0 Δ curl
60 day value = 2.20 × Δ reaction - 3.0 Δ curl
90 day value = 1.80 × Δ reaction - 3.0 Δ curl
120 day value = 1.60 × Δ reaction - 3.0 Δ curl
180 day value = 1.55 × Δ reaction - 3.0 Δ curl
240 day value = 1.50 × Δ reaction - 3.0 Δ curl
360 day value = 1.40 × Δ reaction - 3.0 Δ curl
720 day value = 1.25 × Δ reaction - 3.0 Δ curl

Value "C" - Measurement from position "A" to position "B" (will always be a negative value).

30 day value = -1.40 × Δ curl
60 day value = -1.80 × Δ curl
90 day value = -2.20 × Δ curl
120 day value = -2.40 × Δ curl
180 day value = -2.45 × Δ curl
240 day value = -2.50 × Δ curl
360 day value = -2.60 × Δ curl
720 day value = -2.75 × Δ curl

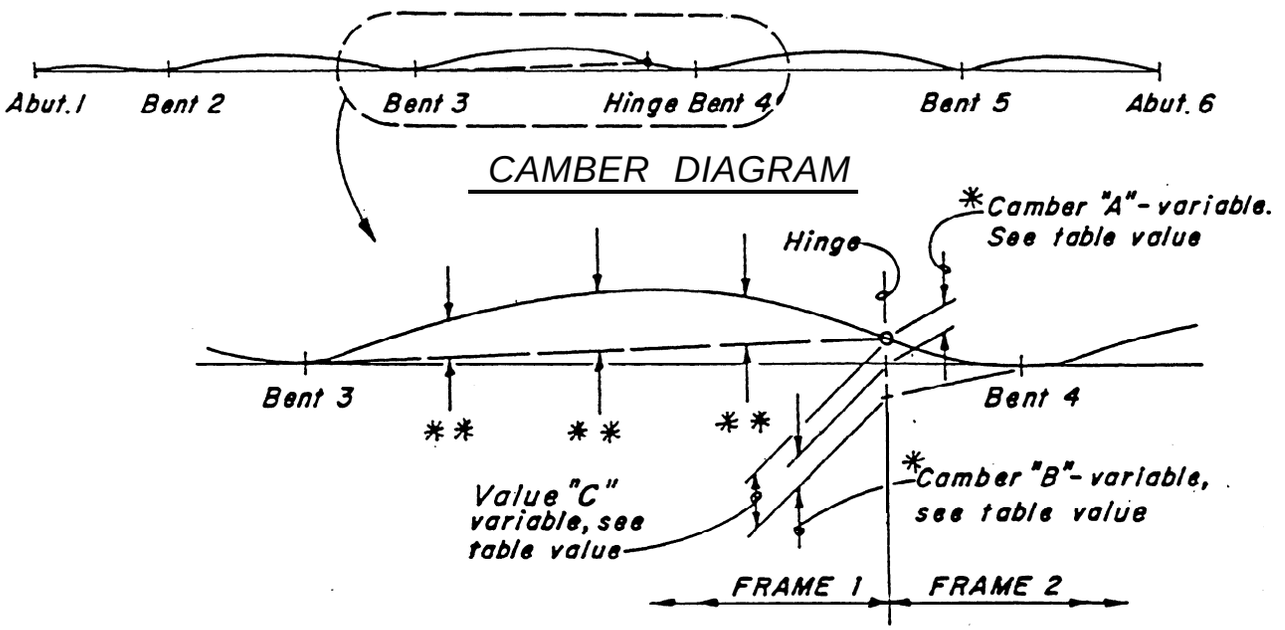


Figure 1. Camber Diagram

* See table for values to use - depends on period of time between prestressing of frame 2 and load transfer from frame 1.

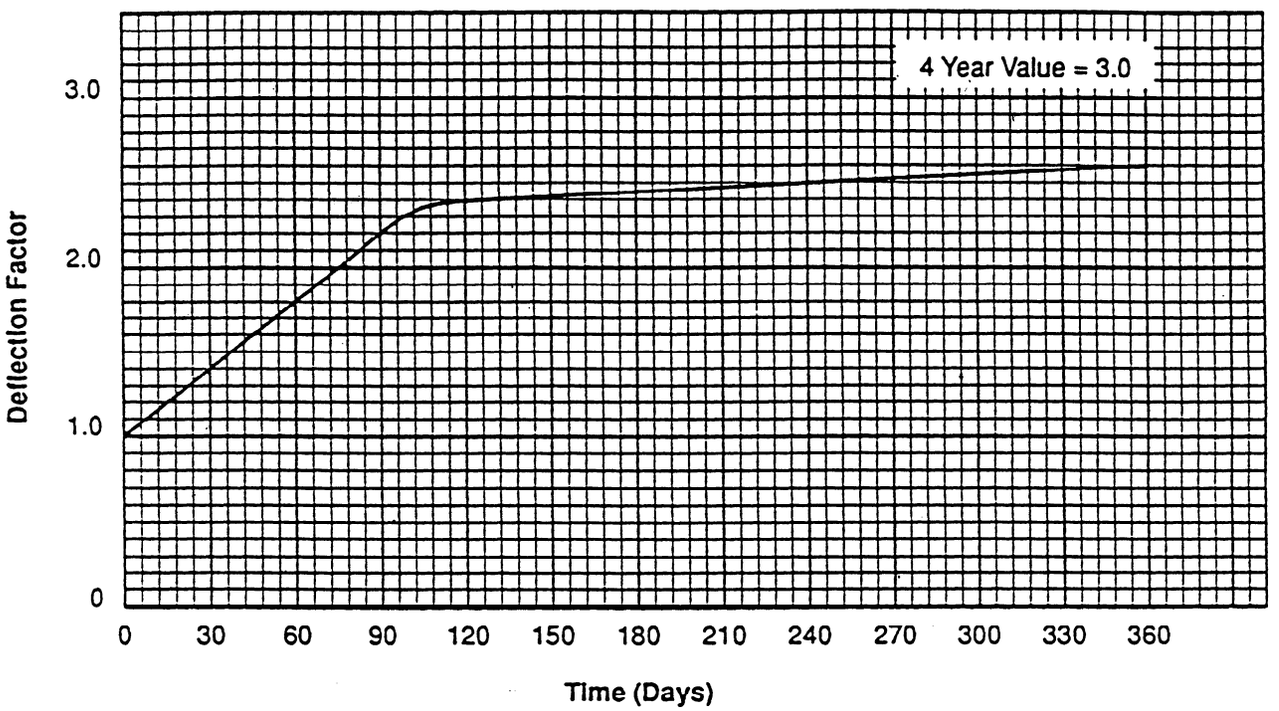
** Adjusted values of camber taken from long hinge values given in complete structure run of BDS.

TIME DEPENDENT CAMBER VALUES

Elapsed time in days measured from prestressing short hinge side till closure and load transfer	Camber "A"	Camber "B"	Value "C"
30 days			
60 days			
90 days			
120 days			
180 days			
240 days			
360 days			
720 days			

Table 1. This table is to be shown on contract plans.

The long term effects that are incorporated in the previous calculations were determined from a plot of time vs. deflection as shown below.



Note: It is assumed that there will be a trial period during which this method of handling camber in hinged spans will be monitored and adjusted as needed.

Philip C Warriner

Guy D. Mancarti

AWD:jgf